FOREST LAND HABITAT MANAGEMENT IN NEW BRUNSWICK

PROGRESS REPORT

Fish and Wildlife Branch
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Fredericton, New Brunswick
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Submitted to

WILDLIFE HABITAT CANADA

9 April 1990

90-06499/

EXECUTIVE SUMMARY

The mandate of the Forest Land Habitat Management Program is to define habitat objectives for Crown land in New Brunswick, and to integrate these into the forest management planning process. Procedures are currently being developed to incorporate habitat supply analysis for mature coniferous forest habitat and deer wintering area habitat into the 1992 Forest Management Plans for Crown Land. Licensees will be developing these plans through 1991 to be submitted to DNRE by late 1991. This imposes a short-term deadline to have habitat supply analysis planning tools in place by early 1991.

There is a legislated responsibility to maintain sufficient habitat to ensure that no wildlife species are at risk. Analyses of the 1987 Forest Management Plans have indicated that supply of mature and overmature coniferous forest will be significantly depleted on the nearly 3 million hectares of managed, non-reserve Crown forest within 30-50 years. White-tailed deer, American marten, black-backed woodpecker and brown creeper were identified as species dependent upon these habitat types.

Mature and overmature coniferous forest objectives in the 1992 management plans will be based upon the habitat requisites of the American marten, a species requiring a relatively large area of these forest types. Analyses will be undertaken to determine the extent to which habitat supplied for marten will also satisfy the habitat requisites of the other species dependent on similar habitat.

There is a separate habitat supply analysis strategy for deer wintering area habitat that incorporates the traditional use of wintering areas by deer. Deer wintering area habitat objectives for the 1992 management plans are to manage the forest to provide critical winter habitat equal in quantity and quality to that currently existing. The locations of known deer wintering areas have been identified and entered into a computer database. Using data from previous deer wintering area habitat surveys, a preliminary definition has been derived of which forest stand types and development stages constitute critical winter habitat. This definition will be refined in 1990 using data from a deer wintering area habitat study undertaken this past winter.

The deer wintering area habitat supply analysis procedure is as follows. The area and age class structure of critical winter habitat and of potential future habitat are determined for each deer wintering area. An attempt is then made to balance the age class structure of the wintering area through incorporation of suitable neighbouring stands. This defines an area which can be managed for a sustained supply of habitat. Currently, the database is being completed, and deer wintering area expansion criteria are being defined.

The details of the planning process by which licensees will conduct habitat supply analysis for the mature coniferous forest and deer wintering area habitat types are currently being refined. This process will also identify and account for overlap between the two habitat types.

TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY	ii
FOREST LAND HABITAT MANAGEMENT IN NEW BRUNSWICK	1
INTRODUCTION	2
HABITAT RELATIONSHIPS DEFINITION	3
White-tailed Deer	3
Marten	4
Forest Birds	4
Habitat Descriptions	4
Habitat Modelling	5
LICENSEE FOREST HABITAT OBJECTIVES	6
White-tailed Deer Winter Habitat	6
Strategy Outline	6
Progress Summary	7
Mature And Overmature Coniferous Forest Habitat	8
Wildlife Technical Committee	10
HABITAT SUPPLY ANALYSIS PROCEDURES	11
Status Of HSA Development	11
Buffer Strip Research Project	12
BUDGET EXPENDITURES	13
APPENDICES	14
APPENDIX 1. Description Of The Forest Development Survey Variables: Forest Unit, Development Stage	15

Page

APPENDIX 2. Example Of A Forest Class Volume Yield Curve And A Winter Habitat Window For White-tailed Deer 18

APPENDIX 3. A Tentative Description Of Forest Stand Attributes Selected By Wintering Populations Of White-tailed Deer 20

APPENDIX 4. Selection Of Forest Structural Attributes By Wintering White-tailed Deer: A Proposal For Analysis And Field Study 36

APPENDIX 5. Example From The Report: Habitat Supply Analysis: Forest Birds In New Brunswick .. 46

APPENDIX 6. Procedure And Guidelines For The Definition Of Deer Wintering Area Management Units .. 48

APPENDIX 7. Example Of A Forest Class Volume Yield Curve And A Habitat Window For Marten 55

APPENDIX 8. New Brunswick Forest Research Advisory Committee (NBFRAC): NBFRAC Wildlife Technical Committee 57

APPENDIX 9. Forest Land Habitat Management Program: Program Staff 60

FOREST LAND HABITAT MANAGEMENT IN NEW BRUNSWICK

The goals of New Brunswick's Forest Land Habitat Management Program (FLHMP) are to define habitat objectives for Crown land that will accommodate desired wildlife population levels and to integrate habitat objectives into the forest management planning process for Crown land in New Brunswick.

The 5-year program is co-sponsored by the New Brunswick Department of Natural Resources and Energy and Wildlife Habitat Canada. This document is the third semiannual Program Progress Report submitted to Wildlife Habitat Canada.

INTRODUCTION

The Forest Land Habitat Management Program (FLHMP) has identified a need to maintain mature and overmature (mature) coniferous forest on crown land. Mature coniferous forest provides unique structural features; it is the required or preferred habitat of a variety of wildlife species.

There is legislated responsibility to maintain sufficient habitat to ensure that no wildlife species are at risk. Analyses of 1987 Forest Management Plans for New Brunswick Crown Land Licenses indicate a significant depletion of mature coniferous forest from the non-reserve forest (areas exclusive of deer wintering areas, watercourse buffer strips and inoperable areas) within 30-50 years.

Analysis of requirements for mature and overmature coniferous forest were based on the habitat requisites of the American marten (Martes americana), a species requiring a relatively large area of these forest types. Analyses will be undertaken to determine the extent to which habitat supplied for marten will also satisfy the habitat requirements of other species dependent on similar habitat. Other species with mature coniferous forest associations for which habitat supply analyses are being conducted are white-tailed deer (Odocoileus virginianus), black-backed woodpecker (Picoides arcticus) and brown creeper (Certhia americana).

Maintenance of mature coniferous forest as wintering habitat for white-tailed deer is a special component of coniferous forest management. Habitat use by white-tailed deer during winter likely involves selection for both stand structure and stand location; traditional use of wintering areas by white-tailed deer is well documented. Maintaining winter habitat for white-tailed deer therefore requires management intervention within, and in proximity to, existing wintering areas.

HABITAT RELATIONSHIPS DEFINITION

WHITE-TAILED DEER

The strategy for management of white-tailed deer winter habitat was outlined in the October 1989 Progress Report and is further described elsewhere in this report. It requires manipulating the forest within Deer Wintering Area Management Units (DWAMU) to maintain the current amount of winter habitat. The success of the strategy depends, in large part, on (1) the extent to which current winter habitat can be described in terms of the DNRE Forest Development Survey (FDS) database and, (2) the accuracy with which predictions can be made about which current forest strata will supply winter habitat in future.

The forest on each Crown Land License was stratified into a manageable number of units to aid in wood supply forecasting. Vegetative attributes used for the stratification included Forest Unit (FU), Development Stage (DS) and Crown Closure (CC). FU is a descriptor of overstory tree species composition; DS is a descriptor of rate of change in wood volume of a stand and is closely related to stand successional stage (see Appendix 1 for descriptions of FUs and DSs). Unique combinations of FU, DS and CC are Forest Classes. Predictions about changes in wood volume over time were made for each forest class for each license. These predictions form the basis for the volume yield curves used in the FORMAN wood supply model. The abundance of white-tailed deer winter habitat is predicted using the WILD30 model, a modification of the FORMAN wood supply model. Within the model, deer winter habitat is a "window" in time on forest class volume yield curves. See Appendix 2 for an example of a forest class volume yield curve with a white-tailed deer winter habitat window overlay. The key relationships questions for deer winter habitat management are which forest classes supply winter habitat and over what range of ages it is supplied.

To date, an analysis of forest structural preferences using data collected in 1986 and 1987 has been completed. It indicates, in coarse terms, which stand attributes deer select and which they avoid. A Chi-square Goodness-of-Fit test was employed for the analysis. Results of the analysis, given in Appendix 3, are being used to define preliminary deer winter habitat windows.

In order to refine the structural definition of preferred deer winter habitat, additional field work was initiated in January 1990. The objective was to describe deer habitat selection in terms of a stand density regime. Stand density is defined by two variables, stand basal area (m^2/ha) and stem density (stems/ha). The proposal for the project is included as Appendix 4.

MARTEN

Initial habitat relationships for marten were defined using information from the literature. The structural features of stands that are of importance to marten were identified, allowing a description of which forest units and which development stages (FU and DS, Forest Development Survey variables, see Appendix 1) are likely suitable for marten. Defined relationships were used to construct the marten habitat model presented in Appendix 2 of the October 1989 Progress Report. Questions about the composition and spatial requirements of marten habitat were sent to all persons currently or recently involved in marten habitat research and (or) management in North America. Responses on composition requirements were incorporated into a redraft of the model in January 1990. The new model was then simplified to interface with the WILD wood/habitat supply model. Inputs to the model are license forest structure (area of each FU/DS combination on the license) and the proposed forest harvest scenario as detailed in Crown Land License management plans. Model constants (for marten) are the age at which each suitable FU becomes marten habitat and the carrying capacity density for marten in suitable habitat (0.5 residents/km^2). Model output is marten carrying capacity for the license, expressed as number of marten. Spatial requirements of marten habitat were defined from letter responses and literature sources. These form the basis of the requirements for spatial configuration of mature coniferous forest habitat, presented in the Licensee Objectives section of this report. The minimum acceptable marten population has been estimated at 250 resident individuals.

FOREST BIRDS

Habitat Descriptions

A report entitled Habitat Supply Analysis: Forest Birds In New Brunswick was completed in October 1989. It comprises a review of the status and habitat requisites of 101 forest-dependent birds in New Brunswick. The primary objective of the undertaking was to describe the habitat requirements of as many non-game species as possible using the Forest Development Survey (FDS) classification.

An intensive literature review was carried out to identify those species most likely to be affected by forest harvest operations in New Brunswick over a long term. Descriptive and quantitative analyses of New Brunswick census data collected in 1988, coupled with extrapolation of census data from literature, were undertaken to determine habitat preferences, population trends and biological requirements. Breeding requirements of cavity/snag nesting birds such as woodpeckers, were further cross-checked using data cards on file with the Maritimes Nest Records Scheme. Experts in the field were consulted in order to assess the progress of similar projects in other provinces. Written descriptions of habitat preferences, biological requisites, population trends, and status were summarized for individual species. Summaries specific to woodpeckers in New Brunswick were: heights of entrances to nests, tree species use, tree diameter class use and cavity type use.

Species of forest birds were deemed suitable for management using habitat supply analysis (HSA) techniques if habitat requirements could be described using FDS variables (see Appendix 1). Based on habitat requisites and on suitability for HSA, a list of species that should be given priority for HSA was provided. An example of the report from the section entitled New Brunswick Forest Bird Habitat Descriptions is given in Appendix 5.

Habitat Modelling

Preliminary habitat models have been constructed for the black-backed woodpecker and the brown creeper. The models are similar to that constructed for American marten and were designed to interface with the WILD supply model.

Black-backed woodpeckers prefer snags or living conifers at least 30.5 cm in diameter for feeding. Nests are usually located in living spruce or balsam fir trees with decayed cores. Black-backed woodpeckers exhibit an avoidance of deciduous forest types. Brown creepers are small forest birds uniquely adapted for gleaning insects from the bark surfaces of trees. Nests are located under loose hanging bark shingles found on coniferous snags at least 25 cm in diameter.

Assignments of suitability for black-backed woodpeckers and brown creeper to forest strata were based primarily on estimates of snag abundance and of snag diameter distributions from New Brunswick Permanent Sample Plot data. Coniferous stands in mature or overmature stages of development were considered suitable for black-backed woodpeckers; coniferous or mixedwood stands in mature or overmature stages of development were considered suitable for brown creepers.

LICENSEE FOREST HABITAT OBJECTIVES

WHITE-TAILED DEER WINTER HABITAT

Initial questions about year-round habitat supply for white-tailed deer were addressed through use of a computer model constructed for the purpose. The model assessed the suitability of an area for white-tailed deer based on the abundance and interspersion of summer food, winter food, security cover and winter thermal cover. Trial runs of the deer model indicated that, of the 4 habitat requirements, winter thermal cover is the component that most likely limits habitat suitability. Although stands providing winter food appear abundant, their contribution to white-tailed deer habitat supply was seen as highly dependant on the degree to which they also provide winter thermal cover or are in close proximity to stands that do. The management strategy for white-tailed deer is therefore primarily concerned with the maintenance of stands providing both suitable winter cover and suitable food. The basic components of the strategy are outlined below.

Strategy Outline

1. Identify existing deer wintering areas (DWA) within the provincial forest development survey (FDS) computer database.

2. Quantify the amount of winter habitat within DWAs and set this amount as a present objective for which to manage.

3. Identify DWA management units (DWAMU) centered on existing DWAs in which the present amount of winter habitat can be maintained over time. Where DWAMUs cannot produce a sustained amount of winter habitat the option will exist to identify DWAMUs in areas not currently identified as DWA.

4. Develop the computer software needed to model habitat availability and integrate deer winter habitat objectives into the forest management modelling system (FORMAN wood supply model).

5. Define the management and operating plan requirements and responsibilities of DNRE and Licensees.

6. Prepare timber harvesting and silvicultural guidelines for DWAMUs.

7. Develop the framework for updating the DWA/DWAMU database.

Progress Summary

1. All DWAs on Crown Land, as identified by DNRE regional staff, have been entered into the FDS computer database. Using the database, area summaries describing the forest structure in each DWA have been produced. Area summaries for the total area of each License and for the aggregate of all DWAs on a License have also been produced. Using DNRE GIS capabilities, a series of 1:50 000 scale maps indicating the location of known DWAs, plantations, precommercially thinned stands and naturally regenerating cutovers have been produced. These allow verification of DWA locations and are used to define DWAMU boundaries. Updates to the database are being made as new information on DWA locations becomes available.

2. A document entitled Procedure And Guidelines For The Establishment of Deer Wintering Area Management Units was prepared and distributed to regional wildlife biologists for comment (Appendix 6). Efforts in 3 DNRE administrative regions by Program and regional staff to establish DWAMUs using the guidelines have revealed a number of problems. In many cases the forest surrounding existing DWAs does not contain the younger development stages required to replace existing winter habitat. Efforts are now under way to address these problems.

3. The WILD wood/habitat supply model will be used to determine availability of winter habitat and to integrate habitat objectives into the forest management modelling system.

4. Requests have been made to jurisdictions in the United States Northeast and Great Lakes areas for information on standards and guidelines for forest management within DWAs. This information, along with existing New Brunswick guidelines, will be reviewed with the goal of developing a comprehensive set of guidelines for use in DWAMUs.

5. A framework for annually updating the DWAMU database has not yet been defined.

MATURE AND OVERMATURE CONIFEROUS FOREST

Analysis of requirements for mature and overmature (mature) coniferous forest were based on the habitat requisites of the American marten. Habitat supply for marten was modelled using the WILD wood/habitat supply model. An analysis of habitat supply for the Upper Miramichi Crown Land License indicated a severe reduction in the availability of marten habitat over the next 40 years (Figure 1). Analyses for 3 of the 9 other licenses have been completed; trends are similar. An assumption made in the analyses was that stands that were suitable for marten would remain so indefinitely if not logged. This may not be so, particularly in stand types that are susceptible to heavy insect damage and windthrow. A priority will be to determine which forest strata are likely to naturally cycle in and out of suitability for marten and to quantify cycle length. See Appendix 7 for an example of a forest class volume yield curve with a marten habitat window overlay. WILD is a non-spatially referenced model, hence size, shape and juxtaposition of stands cannot be included as criteria for assigning value of a land area to wildlife. Projected license carrying capacities are therefore likely to be overestimates.

Planning for the maintenance of mature coniferous forest has been identified as a shared responsibility of Crown Land Licensees and the DNRE. Tentatively, the FLHMP will be responsible for providing the following to Licensees:

1. A list of which forest unit/development stage combinations are expected to provide marten habitat during each 5-year period of the 1992 Management Plans.

2. The required area of mature coniferous forest to be maintained. Maintenance of a population of 250 resident marten requires an area of 500 km^2.

3. The required spatial configuration of mature coniferous forest. Tentative requirements are:

    1. Mature coniferous forest must be provided in blocks of ≥5 km^2; short axes of blocks must be ≥1 km.

    2. Mature coniferous stands must comprise ≥75% of the block; block stands that are not mature coniferous forest must not be at the block edge.

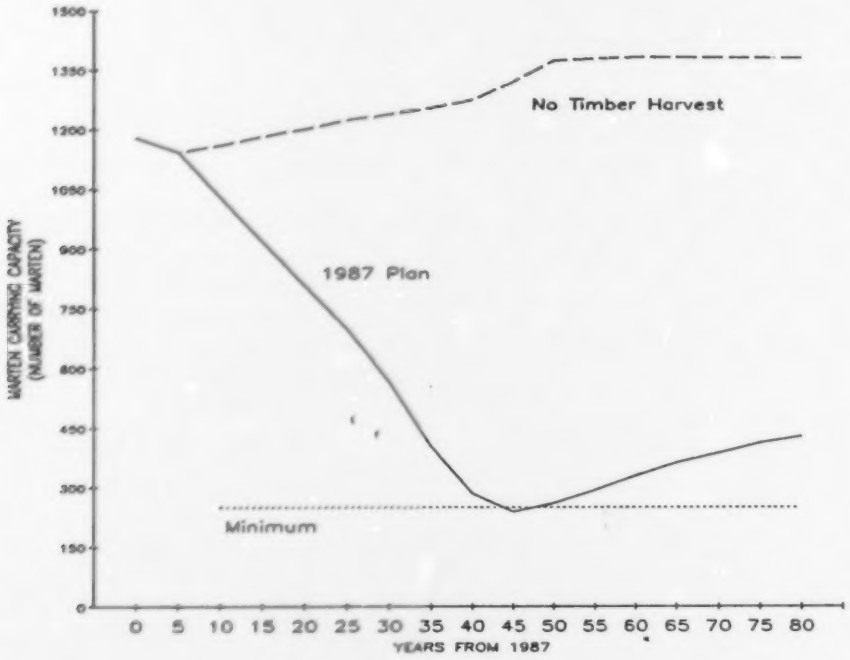


Figure 1. Minimum acceptable population and projected carrying capacity for marten on the Upper Miramichi Crown Land License based on 1987 Forest Management Plan.

3. Blocks of mature coniferous forest must be interconnected by travel corridors in a YOUNG or older development stage; gaps in corridors must not normally exceed 200 m. Riparian buffers are suitable as travel corridors.

4. Blocks of coniferous forest must be within a network of blocks with a total area of ≥500 km^2. This is sufficient area to support a population of 250 adults at an assumed density of 0.5/km^2.

As part of their management plans, licensees will be required to provide the following:

1. Predictions of the area in mature coniferous forest available at the end of each 5-year iteration for the 80-year planning horizon.

2. Forest Development Survey maps indicating where mature coniferous forest is being provided for each of the first seven 5-year periods. To be considered suitable, stands must meet both composition and spatial criteria.

WILDLIFE TECHNICAL COMMITTEE

The Wildlife Technical committee acts as a steering group for the Forest Land Habitat Management Program. It is composed of representatives from the forest industry (Licensees), the University of New Brunswick, and the federal and provincial governments (Appendix 8). The committee meets semiannually, in spring and fall. The most recent meeting was held on 16 March 1990. Dr. A. Boer presented an introduction, overview and status report of a proposed wildlife research unit, to be a cooperative project of the Department of Natural Resources and the University of New Brunswick. Dr. Boer solicited funding for the unit from forest industry representatives. FLHMP staff presented status updates on two projects discussed in this report: White-tailed Deer Winter Habitat Management and Mature and Overmature Coniferous Forest Management. The committee discussed the need to generate a framework and prioritization for applied forest wildlife research; a special meeting of the committee was scheduled for 26 April 1990 to address these issues.

DEVELOPMENT OF HABITAT SUPPLY ANALYSIS PROCEDURES

STATUS OF HSA DEVELOPMENT

The rapidly approaching planning period for the 1992 management plans has focused efforts on programs/procedures that are needed for incorporating Habitat Supply Analysis (HSA) in the 1992 plans. Accordingly, further development of the "stand projector", described in the previous report, has been put on hold for the interim. The computer section has been supporting (through software and product development) the project's development of (1) a deer wintering area habitat strategy, and (2) a mature coniferous forest habitat strategy.

For the Computer Modelling Section, development of the Deer Wintering Area (DWA) Habitat strategy has involved:

1. Defining a DWA inventory database

2. Programming procedures for inputting (capturing in digital form) the locations of the DWAs

3. Programming area summaries and map products to aid in definition of DWA management units

4. Programming a preliminary DWA "habitat window" definition program, for use in WILD-based HSA

Considerable work remains to complete the DWA inventory database and to incorporate the results of the ongoing DWA habitat study into a revised version of the "habitat window" definition program. As well, through 1990, continuing refinement and implementation of the proposed DWA management strategy will define the requirements for additional programs and products.

Development of the mature coniferous habitat strategy has involved:

1. Refinement of the program used to define marten "habitat windows" for use in WILD-based HSA

2. Development of programs for definition of "habitat windows" for both the black-backed woodpecker and the brown creeper

3. Use of these models to quantify mature coniferous habitat supply on several of the northern Crown Land licenses

Through 1990, ongoing development of the mature coniferous forest habitat strategy will pinpoint the need for additional programs and products.

BUFFER STRIP RESEARCH PROJECT

As discussed in previous progress reports, a graduate student (D. Santos) was attempting to implement, on the DNRE computer system, the cartographic modelling procedures for calculating riparian buffer strip widths (developed previously, in a demonstration system, by another graduate student (B. Dick)). The DNRE implementation (case study) was completed and we have received the results in the form of a Master of Forestry report. Further application of this work awaits the availability of the required data in digital form and will necessitate considerable model refinement.

NEW BRUNSWICK
FOREST WILDLIFE HABITAT PROGRAM

BUDGET EXPENDITURES[1]

1 OCTOBER 1989 - 31 MARCH 1990

ACTIVITY	CONTRIBUTOR	
	D.N.R.E.	W.H.C.
Salaries and Benefits	197 098.00	125 641.00
Travel and Activity Expenses	21 607.80	3 565.81
Vehicles and Equipment	13 585.54	5 794.59
Professional Services, Materials and Supplies	12 210.61	2 598.06
Deer Wintering Area Aerial Survey	13 827.75	0.00
Computer Hardware, Software and Support	15 378.07	194.94
TOTAL	273 707.77	137 794.40

GRAND TOTAL = D.N.R.E. + W.H.C.

= 411 502.17

[1] Budget figures will be finalised in mid-May 1990.

APPENDICES

APPENDIX 1.

DESCRIPTION OF THE FOREST DEVELOPMENT SURVEY (FDS) VARIABLES: FOREST UNIT, DEVELOPMENT STAGE.

FDS VARIABLES

Forest Unit (FU)

SPBF	spruce-balsam fir	(SP component includes red, black and white spruce)
BFSP	balsam fir-spruce	
SPIH	spruce-intolerant hardwood	(IH component is primarily aspen and white birch)
IHSP	intolerant hardwood-spruce	
SPTH	spruce-tolerant hardwood	(TH component is primarily sugar and red maple, beech and yellow birch)
THSP	tolerant hardwood-spruce	
BFIH	balsam fir-intolerant hardwood	
IHBF	intolerant hardwood-balsam fir	
BFTH	balsam fir-tolerant hardwood	
THBF	tolerant hardwood-balsam fir	
OTSW	other softwood	(OTSW is primarily eastern white cedar)
PINE	pine	(PINE is primarily jack pine)
INHW	intolerant hardwood	
TOHW	tolerant hardwood	
IHTH	intolerant-tolerant hardwood	
THIH	tolerant-intolerant hardwood	
MSP	SPTH, SPIH, THSP, IHSP	
MBF	BFTH, BFIH, THBF, IHBF	

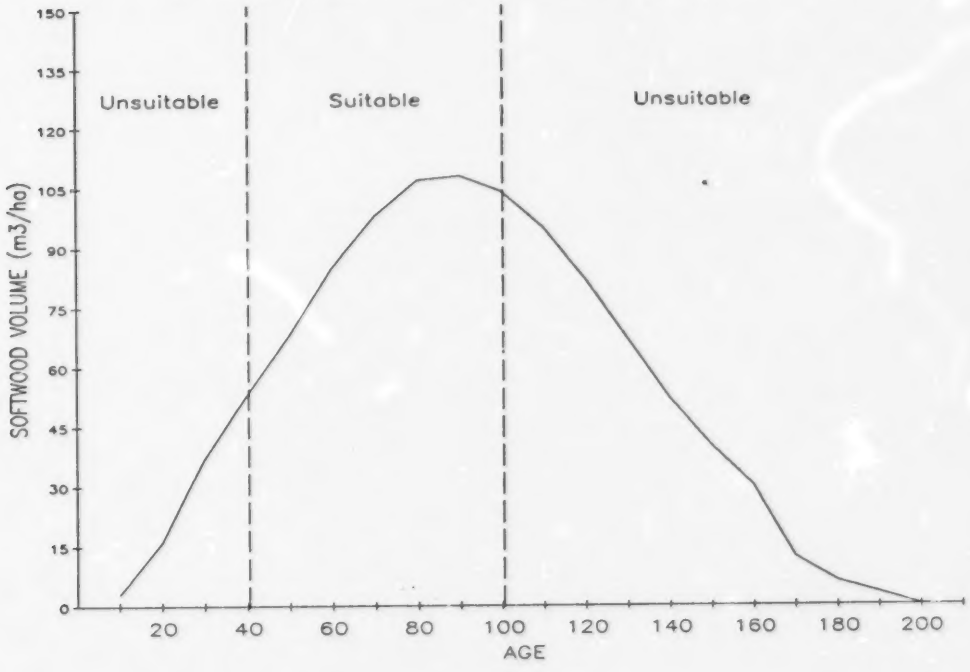
Development Stage (DS)

CUT (C)	Clearcuts and cuts where residual volume form less than 20% crown closure.
REGENERATING (R)	Stands where tree height is approximately 3 metres.
YOUNG (Y)	Stands that are accumulating wood volume at a rapid rate.
IMMATURE (I)	Stands that are still accumulating volume at a reasonable rate but that are older than Y stands and have not yet reached maturity.
MATURE (M)	Stands that are no longer accumulating volume: volume loss due to tree mortality approximately equals volume growth of remaining trees.
OVERMATURE (O)	Stands that are losing volume at a rapid rate: volume loss due to tree mortality exceeds volume growth of remaining trees.

APPENDIX 2.

EXAMPLE OF A FOREST CLASS VOLUME YIELD CURVE AND A WINTER HABITAT WINDOW FOR WHITE-TAILED DEER

LICENSE 4 WHITE-TAILED DEER WINTER HABITAT WINDOW
SPRUCE/TOLERANT HARDWOOD (ALL CROWN CLOSURES)



APPENDIX 3.

A TENTATIVE DESCRIPTION OF FOREST STAND ATTRIBUTES SELECTED BY WINTERING POPULATIONS OF WHITE-TAILED DEER

1.0 Introduction

The objective of the Forest Land Habitat Program (Natural Resources and Energy) is to integrate wildlife habitat management objectives into New Brunswick's forest management planning system. Maintenance of suitable and sufficient white-tailed deer winter habitat is a component of that objective.

Timber supply analysis procedures used to model both forest volumes and habitat supply (i.e., FORMAN, WILD30 (Wang et al. 1987, Vietinghoff 1989)) require as input timber volume yield curves and the identification of when, in time, a "window" of satisfactory wintering habitat suitability occurs for deer. These curves are built for a number of forest stand aggregations, or forest classes. For the purposes of this report, forest classes can be defined as groups of stands, aggregated on the basis of overstory species composition, site productivity and stocking.

To identify windows, a means of relating habitat suitability to forest age is required. This analysis addresses this question by determining if habitat selection, by deer, is governed by overstory age, crown closure, development stage or overstory species composition (or combinations of the above). Development stages, in this context, describe changes in forest volume due to stand aging (Figure 1).

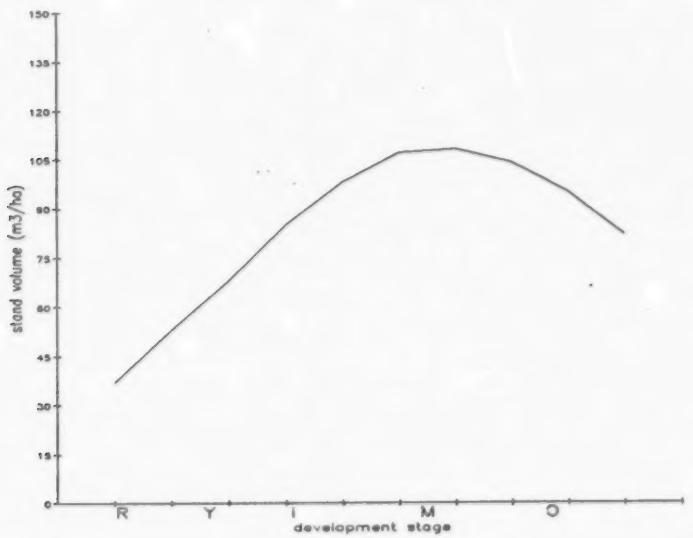


Figure 1. Development stage as defined by standing volume.

2.0 Study area

Deer wintering areas have been identified by regional staff of the New Brunswick Department of Natural Resources and Energy for a number of years. These areas occur throughout the province, however deer use on wintering areas and hence distinctiveness of the areas, is most pronounced in northern New Brunswick, an area with relatively high snowfall.

Vegetation on wintering areas is dominated by complexes of spruce and fir, however a deciduous component and other conifers, such as cedar and hemlock, are also generally found. Forest site productivity on DWAs is likely higher than average (Weber et al. 1981); DWAs are generally associated with riparian zones and water courses.

Forest harvest has occurred on deer wintering areas in the province, frequently in the form of clear (patch) cutting, however strip cutting and selection (group) harvest have also occurred. Silvicultural activities on deer wintering areas exist mainly in the form of planted stock.

3.0 Methods

3.1 Field work (1986,1987 deer wintering area surveys)

Deer wintering area surveys were conducted during the winters of 1986 and 1987 by field crews employed by DNRE. The objective of these surveys was to quantify stand conditions and vertebrate sign (deer and others). Among the stand data collected were overstory species composition, development stage and crown closure. Within DWAs, sampling effort was allocated among forest strata relative to their occurrence.

Within stands, a variety of data were collected. Those of relevance to this analysis were forest unit, development stage, crown closure, and track and bed frequency. Data for the first 3 variables were from aerial photographs. "Tracks" include any distinguishable number of track sets found together or as individual sets, since the last major snow, thaw, rain or wind storm. "Trails" can be fresh (since last disturbance) or old (prior to last disturbance), and are characterized by the presence of a hard packed trail base or a trough. "Beds" were depressions (old or new) caused by deer laying on the snow during resting periods. All indications of deer use were tallied from transects established along the long axis of stands. To be tallied, tracks and trails had to intersect the transect, beds had to be visible from the transect. Transects were established and surveyed from January to March 1986 and 1987.

3.2 Analysis of data

A Chi-square Goodness-of-Fit procedure, employing Bonferroni Z statistics (Neu et al. 1974, Byers and Steinhorst 1984), was used to analyze whether the frequencies of tracks, trails and (or) beds were greater than expected in various forest strata characterized by differences in overstory species composition, development stage and (or) overstory age (see Neu et al. 1990). Significance level was 90%; 90% confidence intervals were constructed around strata means. Development stages examined were R, Y, I, M and O. Stand age ranges examined were 10-30, 31-40, 41-50, 51-70, 71-100 and 101-160 years; overstory species aggregates were SPBF, BFSP, IHBF, IHSP, IHTH, INHW, OTSW, PINE, BFIH, BFTH, TOHW, SPTH, THIH, THSP and THBF. Refer to Appendix 1 for a description of acronyms used. Refer to Figure 2 for a depiction of the Goodness-of-Fit matrix used in assessing habitat preferences.

To assess the influence of stand species composition on habitat selection by deer an additional analysis was conducted. This involved a comparison of species composition (by area) within deer wintering areas and across crown forest licenses. A Chi-Square analysis was subsequently utilized to determine if stand composition, within deer wintering areas (observed stand composition) differed from license wide composition (expected stand composition).

4.0 Results and Discussion

4.1 Species composition of selected forest stands

Stands in deer wintering areas were more frequently in the SPBF, BFSP, PINE, OTSW, MSP and MBF forest units than expected (Table 1).

Within deer yards, the OTSW and MSP strata were most consistently preferred; HW, TOHW, THIH and IHTH were avoided (Table 2). The INHW strata, however, was occasionally used, possibly due to the presence of a coniferous understory, in the case of two-storied stands, or due to the relatively greater abundance of browse due to the intolerant deciduous overstory (Zavitkovsky 1976). The SPBF strata was not consistently selected, in contrast to reports by others (e.g., Marchington and Hirth 1984). An explanation may be that the SPBF aggregate constitutes a large number of stands, in which black spruce, a dominant occupying poor sites (Zelazny et al. 1989), is often included. Poor sites are avoided by deer (Weber et al. 1981).

	Category i			
Forest Class	SPBF/Y	SPBF/I	SPBF/M	SPBF/O
Observed use (e.g., no. of browsed stems) (O)	10	10	200	150
Expected use (E)	92.5	92.5	92.5	92.5
No. of plots (P)	64	64	64	64

Chi-square Goodness-of-fit test statistic:

$$X^2 = \Sigma \frac{(O_i - E_i)^2}{E_i},$$

where O_i and E_i are the observed and expected use of the ith forest class, respectively, and

$$E_i = \frac{P \times \Sigma O_i}{\Sigma P_i},$$

where P_i is the number of samples in the ith forest class.

Figure 2. Example of proposed Chi-square Goodness-of-Fit analysis of hypothetical data, comparing deer use of various forest classes.

Table 1. Forest composition of deer wintering areas on 3 Crown Land Licenses in northern New Brunswick.

Forest Unit	License 1		License 2		License 3	
	Obs[1]	Exp[2]	Obs	Exp	Obs	Exp
SPBF	5673*	2785	2024*	2801	1009*	1405
BFSP	9530*	11054	3611*	2975	295*	173
PINE	1407*	494	223	197	364*	184
OTSW	2072*	1387	457*	527	263*	215
MSP	986*	681	415*	499	640*	538
MBF	2063*	3727	1156*	896	183	168
HW	694*	2214	351	325	37*	85
INHW	881	914	238	256	90*	113

[1] Observed number of hectares of each strata in DWAs
[2] Expected number of hectares of each strata on DWAs, based on proportion of same on license
* Significant at $P \leq 0.10$

Table 2. Forest units selected by white-tailed deer within wintering areas, as indicated by frequencies of tracks, trails and beds. Forest strata are mature and overmature.

Forest Unit	Tracks		Trails		Beds	
	Obs[1]	Exp[2]	Obs	Exp	Obs	Exp
MBF	249*	291	47	48	24*	37
MSP	1214*	748	140	124	177*	95
HW	37*	155	1*	26	4*	19
INHW	118*	85	7	14	27*	11
PINE	43*	87	11	14	1*	11
OTSW	713*	283	159*	47	64*	36
BFSP	348*	748	79*	125	17*	95
SPBF	1409*	1733	244*	289	209	219

[1] Observed: number of tracks, trails or beds observed in each stratum.
[2] Expected: number of tracks, trails or beds expected in each stratum
* Significant at $P \leq 0.10$

The preference for MSP and OTSW was consistent with that reported elsewhere. Potvin and Huot (1983) documented the composition of deer wintering areas, which included 21-60% "mixed growth" and lesser amounts of white cedar. Browse production and, hence, metabolizable energy, is higher in mixed growth types than in cedar, hemlock, balsam fir-spruce-pine, deciduous, abandoned cutover and nonforested swamp types (Potvin and Huot 1983). Within cedar dominated types, browse production is relatively low, however cedar is highly preferred by deer and is able to supply winter food requirements (Verme and Ullrey 1984). Cedar stands also provide the narrowest winter thermal range, the most stable relative humidity regime and least wind flow (Verme 1985).

4.2 Selection of forest structural attributes by deer

4.2.1 Crown closure attributes

From a conceptual stand point, overstory crown closure should have a marked influence on habitat selection in deer. Denser stands intercept more snow, providing greater ease of movement by deer (Mattfeld 1974, Dickison and Daugharty 1982). Analysis of energy metabolism in deer also suggests that shelter is important in cold weather (Silver et al. 1971, Mattfeld 1974). Excessively dense stands, however, limit light and moisture penetration and hence limit understory biomass production. Stands dominated by conifers with medium to high crown closures should therefore be preferred. Results of the analyses generally support this, with the exception of BFSP forest unit (Table 3). Without further analysis it is difficult to determine why selection, within the BFSP class, was for lower crown closures.

4.2.2 Influence of forest succession on habitat selection by deer

Selection by deer for stand age and development stage, two attributes related to forest succession, was examined. Forest communities proceed from herbaceous to shrub dominated communities and finally to mature and overmature forest (Thomas et al. 1979). Within overmature stands, forest gaps are created by mortality within the canopy. This releases understory vegetation, more food is made available for deer (Clebsch and Busing 1989, Anderson et al. 1969). Mature or overmature softwood-dominated stands should therefore be preferred by deer. Results are generally consistent with this expectation: a selection occurs for older successional stages (Tables 4 and 5). In the case of SPBF, however, track and trail data indicate a selection by deer for younger successional stages (Tables 4 and 5). This is inconsistent with results from the analysis

Table 3. Crown closure ranges selected by white-tailed deer within wintering areas, as indicated by frequencies of tracks, trails and beds. Forest strata are mature and overmature, coniferous and mixed coniferous.

Forest Unit	Crown Closure (%)	Tracks		Trails		Beds	
		Obs[1]	Exp[2]	Obs	Exp	Obs	Exp
SPBF	10-30	370*	319	39	46	34	43
	31-50	622*	733	72*	106	80*	98
	51-70	1177	1179	222*	171	179*	157
	71-90	248*	187	17*	27	30	25
OTSW	10-30	27*	180	1*	33	Data not	
	31-50	265	241	32*	44	sufficient	
	51-70	728*	589	153*	109	n <100	
	71-90	0*	10				
BFSP	10-30	243*	131	28	23	Data not	
	31-50	175	186	29	33	sufficient	
	51-70	266*	329	56	58	n <100	
	71-90	84*	122	23	22		
SPTH	10-30	24*	42	0*	7	Data not	
	31-50	276	255	68*	42.5	sufficient	
	51-70	414	405	51*	69.5	n <100	
	71-90	0*	12				
SPIH	10-30			Data not		Data not	
	31-50	33*	96	sufficient		sufficient	
	51-70	321*	258	n <100		n <100	
	71-90						
THSP	10-30	0*	7.6	Data not		Data not	
	31-50	10*	24.1	sufficient		sufficient	
	51-70	142*	97.6	n <100		n <100	
	71-90	0*	22.7				
IHSP	10-30	0*	8.9	Data not		Data not	
	31-50	170*	229.2	sufficient		sufficient	
	51-70	182*	213.5	n <100		n <100	
	71-90	137*	37.3				
BFTH	10-50	1*	18	Data not		Data not	
	51-70	101*	84	sufficient		sufficient	
	71-90			n <100		n <100	

Continued

Table 3. Continued

Forest Unit	Crown Closure (%)	Tracks		Trails		Beds	
		Obs[1]	Exp[2]	Obs	Exp	Obs	Exp
THBF	10-30	Data not sufficient n <100		Data not sufficient n <100		Data not sufficient n <100	
	31-50						
	51-70						
	71-90						
IHBF	10-30	Data not sufficient n <100		Data not sufficient n <100		Data not sufficient n <100	
	31-50						
	51-70						
	71-90						
BFIH	10-30	Data not sufficient n <100		Data not sufficient n <100		Data not sufficient n <100	
	31-50						
	51-70						
	71-90						
PINE	10-30	Data not sufficient n <100		Data not sufficient n <100		Data not sufficient n <100	
	31-50						
	51-70						
	71-90						

[1] Observed: number of tracks, trails or beds observed in each stratum.
[2] Expected: number of tracks, trails or beds expected in each stratum
* Significant at $P \leq 0.10$

Table 4. Development stages selected by white-tailed deer within wintering areas, as indicated by frequency of tracks, trails and beds. Forest strata are coniferous and mixed coniferous, 30 to 90% crown closure.

Forest Unit	Development Stage	Tracks		Trails		Beds	
		Obs[1]	Exp[2]	Obs	Exp	Obs	Exp
SPBF	Regenerating	87*	33.2	9	6.1		
	Young	11	8.5	9	6.1		
	R + I					0*	5.1
	Immature	368*	37.5	40	44.3	17*	37.5
	Mature	1904*	2024.0	299	294.1	275*	248.8
	Overmature	128	126.9	15	18.4	15	15.6
BFSP	R + Y	1*	6.4			Data not sufficient n <100	
	R + Y + I			0*	7.5		
	Immature	12*	31.0				
	Mature	482*	456.2	103*	92.1		
	Overmature	40	41.4	5	8.3		
SPTH	Regenerating					Data not sufficient n <100	
	Young						
	Immature	56*	116	1*	18		
	Mature	635*	608				
	Overmature	63*	30				
	M + O			115*	98		
SPIH	Regenerating			Data not sufficient n <100		Data not sufficient n <100	
	Young						
	Immature	73*	55				
	Mature	332*	307				
	Overmature	1*	44				
THSP	Regenerating	Data not sufficient n <100		Data not sufficient n <100		Data not sufficient n <100	
	Young						
	Immature						
	Mature						
	Overmature						
OTSW	Regenerating	2*	11	1*	11	Data not sufficient n <100	
	Young						
	Immature	9*	46				
	Mature	968*	835	191*	161		
	Overmature	21*	108	1*	21		

Continued

Table 4. Continued

Forest Unit	Development Stage	Tracks Obs	Tracks Exp	Trails Obs	Trails Exp	Beds Obs	Beds Exp
BFTH	Regenerating			Data not sufficient n <100		Data not sufficient n <100	
	Young						
	Immature						
	Mature	112*	105				
	Overmature	0*	7				
BFIH	Regenerating	Data not sufficient n <100		Data not sufficient n <100		Data not sufficient n <100	
	Young						
	Immature						
	Mature						
	Overmature						
THBF	Regenerating	Data not sufficient n <100		Data not sufficient n <100		Data not sufficient n <100	
	Young						
	Immature						
	Mature						
	Overmature						
IHBF	Regenerating	Data not sufficient n <100		Data not sufficient n <100		Data not sufficient n <100	
	Young						
	Immature						
	Mature						
	Overmature						
IHSP	Regenerating			Data not sufficient n <100		Data not sufficient n <100	
	Young	0*	7.8				
	Immature	6*	31.9				
	Mature	534*	487.3				
	Overmature	1*	13.8				
PINE	Regenerating	Data not sufficient n <100		Data not sufficient n <100		Data not sufficient n <100	
	Young						
	Immature						
	Mature						
	Overmature						

[1] Observed: number of tracks, trails or beds observed in each stratum.

[2] Expected: number of tracks, trails or beds expected in each stratum

* Significant at $P \leq 0.10$

Table 5. Overstory age ranges selected by white-tailed deer within wintering areas, as indicated by frequency of tracks, trails and beds. Forest strata are coniferous and mixed coniferous, all crown closures.

Forest Unit	Overstory Age (years)	Tracks		Trails		Beds	
		Obs[1]	Exp[2]	Obs	Exp	Obs	Exp
SPBF	10-30	48	34	19*	5.1		
	31-40	113*	41	13	6.1	4*	8.7
	41-50	118*	147	5*	22.1	12	17.2
	51-70	794*	989	89*	148.8	108	115.9
	71-100	1248*	992	225*	149.3	135	116.3
	101-160	111*	229	15*	34.4	26	26.8
OTSW	10-30					Data not sufficient n <100	
	31-40						
	41-50	1*	9.7				
	51-70	275	251.7	18*	50		
	71-100	574	580.4	117	110		
	101-160	95	103.0	44*	20		
BFSP	10-30	3	6.3	Data not sufficient n <100		Data not sufficient n <100	
	31-40	45*	10.2				
	41-50	29*	44.0				
	51-70	253*	235.5				
	71-100	58*	85.2				
	101-160	0*	6.4				
SPTH	10-30						
	31-40	1*	15				
	41-50	148*	54	11	11.8	18*	7.7
	51-70	249*	279	59	48.2	28	31.6
	71-100	275	276	46	47.6	30	31.2
	101-160	0*	49	0	8.4	0*	5.5
SPIH	10-30			Data not sufficient n <100		Data not sufficient n <100	
	31-40	11	7.9				
	41-50	77*	9.4				
	51-70	90*	186.5				
	71-100	212*	186.1				
	101-160						
THSP	10-50	113	19	Data not sufficient n <100		Data not sufficient n <100	
	51-70	8*	59				
	71-100	35*	57				
	101-160	0*	21				

Continued

Table 5. Continued

Forest Unit	Overstory Age (years)	Tracks Obs[1]	Tracks Exp[2]	Trails Obs	Trails Exp	Beds Obs	Beds Exp
IHSP	31-40	0*	23	Data not sufficient n <100		Data not sufficient n <100	
	41-50	41*	97				
	51-70	367*	315				
	71-100	59*	32				
	101-160						
BFTH	10-30			Data not sufficient n <100		Data not sufficient n <100	
	31-40						
	41-50	4*	21				
	51-70	46*	30				
	71-100	57	56				
	101-160						
BFIH	10-30	Data not sufficient n <100					
	31-40						
	41-50						
	51-70						
	71-100						
	101-160						
IHBF	10-30	Data not sufficient n <100					
	31-40						
	41-50						
	51-70						
	71-100						
	101-160						
THBF	10-30	Data not sufficient n <100					
	31-40						
	41-50						
	51-70						
	71-100						
	101-160						
PINE	10-30	Data not sufficient n <100					
	31-40						
	41-50						
	51-70						
	71-100						
	101-160						

[1] Observed: number of tracks, trails or beds observed in each stratum.

[2] Expected: number of tracks, trails or beds expected in each stratum * Significant at $P \leq 0.10$

of bed frequency, which indicate that mature stands are preferred. I suggest that mature stands are likely being used as cover sources and that younger stages are being used as feeding areas.

5.0 Suggested use of these data for forest management purposes

Recommendations should be viewed as tentative. Additional data are presently being collected (Niederleitner et al. 1990); these should help to further elucidate the question of which forest structural attributes are selected by deer. Analyses will include: selection for stand density regimes (as depicted by overstory stem density and basal area), and influence of site quality (as described by Zelazny et al. 1989) on habitat selection. For the interim, Table 6 is a summary of recommendations which should assist in the placement of suitability windows in sequences of secondary (post harvest) stand succession.

Table 6. Recommended guidelines for placement of wintering habitat suitability windows on forest development curves.

Forest Unit	Crown Closure (%)	Development Stage	Age (years)
High Value			
SPBF	50-90	ND[1]	70-100
OTSW	50-70	M,O	71-160
BFSP	10-50	M	51-70
MSP	50-90	M,O	40-100
Lower Value			
MBF	50-90	M	50-100
PINE	50-90	ND	ND

[1] ND: Not sufficient data to provide estimate

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APPENDIX 4.

SELECTION OF FOREST STRUCTURAL ATTRIBUTES BY WINTERING WHITE-TAILED DEER: A PROPOSAL FOR ANALYSIS AND FIELD STUDY

1.0 Background information

The objective of the Forest Land Habitat Management Program of the Department of Natural Resources and Energy is to integrate wildlife habitat objectives into New Brunswick's forest management planning system. Maintenance of suitable and sufficient white-tailed deer winter habitat is a component of that objective.

FORMAN, a sequential inventory projection model, is currently used to calculate the sustainable wood supply from each Crown Timber License (Wang et al. 1987). WILD30 (Vietinghoff 1989), a modification of FORMAN, will be used to assess the availability of white-tailed deer winter habitat over time within, and in proximity to, currently defined deer wintering areas (DWA). Within WILD30, suitability of stands is a function of forest structure; suitability changes as stands progress through succession and are harvested.

The use of the WILD30 model to predict abundance of deer winter habitat requires knowledge of when and for how long stands in each forest unit (aggregate of stands by similarity in overstory species composition) are suitable as winter habitat. The principal inputs to WILD30 consist of a series of curves depicting wood volume yield over time; suitable winter habitat will be depicted as "windows" on volume yield curves. The location of winter habitat windows on volume yield curves will indicate the time required after harvesting for stands to become suitable winter habitat and the length of time over which they remain suitable. This information will be used to determine forest harvest rates for areas used by deer in winter that will allow for the maintenance of winter habitat over time.

To determine the length of time over which suitable habitats will persist requires that suitable stand structures be defined. This study will address this question by determining the importance of a number of forest structural attributes, namely stand density, stand basal area, stand age, wood volume and site productivity to wintering white-tailed deer. This information will then be used to build a structural definition (stocking/ stand density) which depicts preferred shelter habitat. Windows of habitat suitability can then be determined by relating the structural definition of preferred habitat to the forest volume predictions developed by Timber Management Branch (TMB), DNRE, for wood supply analyses.

1.1 Factors governing the suitability of wintering areas to populations of white-tailed deer

1.1.1 Influence of snow: a constraint to deer habitat suitability

Snow depth and snow density are both variables affecting ungulate populations. Snow depth has frequently been considered the most important factor influencing ease of movement through snow. Energetic expenditure incurred during locomotion through snow increase exponentially with increasing snow depth (Parker et al. 1984, Mattfeld 1974). Sinking up to or beyond brisket height cause deer to adopt a bounding gait. White-tailed deer soon collapsed during trials in which deep snows were traversed (Mattfeld 1974). Moen (1978) illustrated that the metabolic demand to deer of travelling through snow ≥50 cm was equivalent to that of a "large amount of running". Snow imposes restrictive conditions on deer when depths reach or exceed 30 cm (Telfer 1970); deer are essentially confined when snow depths reach or exceed 50 cm.

Snow density affects energetic expenditures in that less dense snow conditions, at a given depth, require lower energetic expenditures. Parker et al. (1984) suggested that denser snow necessitates higher lifting of legs and, consequently, a higher energetic expenditure.

In northern and central New Brunswick, snow depths in the open commonly exceed 50 cm by January 31 (Devenney 1989, NB Dept. of Environment); deep snow persists into April. The potential for stressful conditions to develop on deer range is therefore high for much of the province.

1.1.2 Effect of extreme temperatures

An energetic cost to deer is incurred as a result of low ambient temperatures. Assessments of thermoregulation in mule deer and of heat production in white-tailed deer indicate that extreme temperatures cause elevated metabolic rates (Parker et al. 1984, Silver et al. 1971). For white-tailed deer, heat production at -16°C is roughly twice that at basal metabolic rate (Silver et al. 1971).

1.1.3 Forage quality and forage distribution

During winter, deer increase their use of deciduous browse, particularly in southeastern Canada (Huot et al. 1984) and in the northeastern U.S. (Mattfeld 1984). Forage quality, as determined by digestibility, is therefore lower during winter and consequently may limit the wintering condition of deer (Crawford 1982, Mautz 1978).

At low forage density, forage distribution also impacts deer. Deer attempt to maintain constant forage intake rates by increasing bite rate and/or travel rate (Spalinger et al 1988). However, when forage density becomes very low, travel rate and bite rate do not fully compensate for low forage availability, consequently forage intake rate declines. This, given the presence of winter snows and in many cases the absence of alternative foods, contributes to stressful winter conditions.

1.2 Amelioration of stress causing factors (physical and vegetative) by the forest overstory and the influence of site productivity on habitat suitability

1.2.1 Crown closure of a coniferous overstory

Snow depth, temperature and forage distribution are all influenced by canopy coverage of the coniferous overstory. Snow water equivalent and snow depth (at maximum snow pack conditions) were found to be less in stands dominated by conifers than in stands dominated by deciduous species (Dickison and Daugharty 1982). The amount of snow intercepted by an individual tree is related to tree species, branch size, angle, flexibility and density and to foliage morphology (Bunnell et al. 1985). Up to 30% of intercepted snow can be lost to sublimation (Schmidt et al. 1988).

The interception of precipitation and sunlight by a forest canopy reduces understory forage abundance; patchy canopies influence forage distribution by increasing abundance as patchiness increases (Anderson et al. 1969, Crawford 1976, Harcombe 1984). Plants establishing themselves following partial or total removal of the overstory are more palatable and may offer greater nutrient availability (Harcombe 1984, MacMahon 1980, Hanley et al. 1985).

Coniferous overstory canopies reduce the energetic cost of thermoregulation to deer by emitting long-wave radiation and by reflecting radiation emitted from the ground. The degree to which a stand can provide higher understory temperatures is directly related to its coniferous crown closure or, more specifically, to its cumulative coniferous leaf area (Reifsnyder and Lull 1965, Anderson et al. 1969, Geiger 1966, Bunnell et al 1986). The intensity of long-wave emission can be predicted by stand density index (Bunnell et al. 1986). Wind speed is reduced in coniferous stands due to obstruction by both the understory and overstory (Geiger 1966, Thomas 1979), thereby reducing convective heat loss by deer.

1.2.2 Site attributes and their influence on plant communities

Browse abundance and diversity are in part related to site characteristics. According to Zelazny et al. (1989), many of the species that are preferred as browse (e.g., maples Acer spicatum, A. rubrum, A. saccharum, A. pensylvanicum) are more likely to occur on productive sites. Forest site productivity indices have been found to explain site selection in deer yarding behaviour (Weber et al. 1983).

2.0 Rationale for study, and study objective

During winter, net energy gain of white-tailed deer is reduced by (1) locomotion through deep and (or) dense snow, (2) thermoregulation in conditions of low ambient temperature and (3) reduced availability and quality of forage. Coniferous stands of "suboptimal" stocking, in which the incomplete canopies provide shelter from snow, wind, and cold yet also allow the establishment of browse sources are therefore likely to be selected by wintering deer. This study will examine whether selection among stand structures (as characterized by stand stem density and basal area) occurs.

Due to logistical constraints associated with obtaining adequate sample sizes for statistical analyses, sampling will be restricted to the YOUNG (Y), IMMATURE (I), MATURE (M) and OVERMATURE (O) development stages of the Spruce-Balsam Fir (SPBF) forest unit and to the YOUNG and OVERMATURE development stages of the Balsam Fir-Spruce (BFSP) forest unit. The implications of this sampling strategy are that selection among forest units by deer cannot be detected, and that structural definition of preferred shelter habitat will be primarily for the SPBF forest unit. The application of data collected in one forest unit to define suitability windows for other units assumes that coniferous species composition is of less importance to deer use than is structure. Coniferous stands in the YOUNG development stages are uncommon within defined DWA boundaries; sampling YOUNG stands in both SPBF and BFSP will increase the sample size for that development stage. The development stage for which structure is most likely to vary among forest units is OVERMATURE; sampling in the BFSP/O forest class (each forest unit/development stage combination is termed a forest class) will allow a comparison of both deer use and vegetative structure between this and the SPBF/O forest class.

3.0 Proposed field work and methods

The question addressed by field work will be whether stand structure is a key variable governing habitat selection. The SPBF forest unit was selected because it is common within deer wintering areas. Stand structure will be described by the following variables: stand density index (a variable incorporating both stem density and basal area), development stage, overstory age and wood volume.

To address whether selection of forest structural attributes by wintering deer occurs, an analysis of habitat selection is proposed. This will involve a Chi-square Goodness-of-fit design (Neu et al. 1974). The Chi-square design has been successfully employed for habitat selection studies in the past and is considered superior to other similar statistical designs (Alldredge and Ratti 1986). A total sample of 300-400 deer-use and forest structure observations, in 5 forest classes, is proposed. This sample design should give acceptable Types I and II error rates (Alldredge and Ratti 1986).

In the Chi-square Goodness-of-fit analyses, differences between expected and observed habitat use will determine whether selection for forest classes occurs. Bonferroni Z statistics will be employed to test for significance (Miller 1981). Small values in the "expected" category reduce the power of Chi-square tests (Miller 1981), hence sampling effort will initially be allocated equally among forest classes.

3.1 Proposed data collection and deer yard selection

The 300-400 stands selected for sampling will be allocated among 6 forest classes (SPBF/Y, I, M, O, BFSP/Y and O). Stands will be located in 4 or 5 discrete deer yards in the northern two thirds of the province (where mid-winter snow depths exceed 50 cm); sampled yards will be dispersed over this region as much as possible. DWA boundaries will be those identified by Natural Resources and Energy regional staff.

3.2 Selection of stands

Sampled stands will be allocated equally among the 30 DWA/forest class combinations (assuming 5 DWAs), subject to constraints given in 3.1, above. Within each DWA/forest class, stands will be selected randomly. Selected stands should be rejected if they are (1) contiguous with previously selected stands, (2) $\leq$200 m from a stand with a CUT development stage assignment, or (3) have areas <5 or >15 ha.

3.3 Parameters measured within stands

3.3.1 Deer use indicators

Numbers of deer beds and of browsed stems will be tallied on belt transects. Transects will be continuous along the long axes of stands; transect widths will be 4 m for browsed stem counts and 10 m for bed counts. Browsed stems are those where 30% of twigs have been browsed by ungulates. Numbers of deer tracks and of trails that cross the observer line of travel will be tallied. The presence or absence of deer and/or moose pellet groups will also be tallied to assist in determining whether tallied sign was exclusively deer, or deer and moose, or moose only. In addition, moose tracks, coyote tracks, marten tracks and associated sign will be tallied.

3.3.2 Vegetation assessment

Vegetation will be assessed at 3-8 locations in each stand, at a regular spacing along deer-use transects. Data collected at each location will consist of a prism sweep (for stem density and stand basal area) and heights and ages of dominant trees.

Information on site productivity will be collected during summer 1990 in the same stands that will be sampled during winter 1989-90. Data will be collected in a manner that is consistent with Site Classification procedures devised by Timber Management Branch.

3.3.3 Field Manual

Refer to the appended field manual for a detailed description of methods and standards to be used in the field.

4.0 Future questions

In order to better understand white-tailed deer habitat relationships, it is suggested that the proposed study be replicated in future years to incorporate among year variation in climate and in area selection by deer.

It has been postulated that deer "condition", as indicated by blood serum proteins, urine analysis, parasite loads and/or antler beam parameters can indicate habitat suitability. It may be useful to monitor these in response to induced habitat change and to relate these parameters to survival rates of deer utilizing wintering areas. Radio telemetry would assist in addressing this question, and

would also permit a precise analysis of habitat selection or preference. Telemetry would also allow one to monitor home range size and migration patterns, which one would expect to change with concurrent changes in habitat (Nyberg et al. 1989).

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APPENDIX 5.

EXAMPLE FROM THE REPORT:
HABITAT SUPPLY ANALYSIS: FOREST BIRDS IN NEW BRUNSWICK

PILEATED WOODPECKER (Dryocopus pileatus): *

Uses mature and overmature mixed wood and pure stands of both deciduous and coniferous forest. Tolerant deciduous forests preferred = yellow birch, beech & maple; intolerant deciduous preferred = poplar and/or white birch, but most often in mixed woods; coniferous forests preferred = hemlock, white pine; mixed wood forest preferred = mature coniferous spruce, pine, hemlock with presence of mature intolerant deciduous snags or trees in breakup stage. Pileated woodpecker numbers were stable or increased slightly in the eastern region of the Breeding Bird Survey between 1965 and 1979. R.F. Whitcomb et al. (1981) concluded that pileated woodpeckers were not as sensitive to the effects of forest fragmentation as neotropical migrants, providing that the area of habitat was sufficient. This view is in concurrence with that of Bent (1939) who suggested that pileated woodpeckers were adapting to suburban growth as long as patches of mature forest remained connected by corridors. However, Robbins et al. (1989) later qualified this, noting that pileated woodpeckers probably reach the maximum level of occurrence in the largest forests (3000+ hectares) as do several neotropical migrants. They state that populations may be reduced by as much as 50% in forests less than 165 hectares in size. Pileated woodpeckers depend upon the availability of large snags to excavate nest cavities and to forage for insect prey (carpenter ants, beetles etc.). Typically, such trees are of large diameter (>38 cm dbh). Of 12 nests examined in New Brunswick where the species of cavity tree was identified, 4 were in poplar, 3 in each of beech and birch, one each in pine and elm. The mean height to the entrance of these nests was 9.23 meters (SD = 4.26). Based on censuses conducted among 20 forest classes in New Brunswick in 1988, preferences were noted in the following order: Overmature Spruce; Overmature Black Spruce, Overmature Spruce/Balsam Fir; Mature Mixed Coniferous/Deciduous; Mature Mixed (Intolerant Deciduous Dominant); Mature Balsam Fir; Mature Spruce/Balsam Fir. REFERENCES: Bent, A.C. 1939; Bull, E.L. and E.C. Meslow 1977; Conner, R.N. et al. 1975; Conner, R.N. 1981; Evans, K.E. and R.N. Conner 1979; Godfrey, W.E. 1986; Kendeigh, S.C. 1946; Kilham, L. 1959; Pinowski, B.C. 1977; Rabenold, K.N. 1978; Robbins, C.S. et al. 1986, 1989; Sanders, C.J. 1970; Schemnitz, S.D. 1976; Thomas, J.W. et al. 1979; Schroeder, R.L. 1983c; Webb, W.L. et al. 1977; Whitcomb, R.F. et al. 1981 ; Yeager, L.E. 1955; Zarnowitz, J.E.. and D.A. Manuwal 1985.

APPENDIX 6.

PROCEDURE AND GUIDELINES FOR THE DEFINITION OF DEER WINTERING AREA MANAGEMENT UNITS

INTRODUCTION

A deer wintering area management unit (DWAMU) is an area in which the forest management objective is to provide a sustained yield of winter habitat. A DWAMU should contain forest stands currently utilized by deer for winter habitat and stands that are capable of providing winter habitat in the future. Ideally a DWAMU would be capable of providing a sustainable supply of winter habitat through time. The following outlines procedures and guidelines designed to assist the user in the definition of DWAMU boundaries.

Current Shelter Habitat. During winter deer often use areas which offer a moderated climatic regime, reduced snow depths which ease movement and an accessible food supply. In New Brunswick the degree to which deer utilize and require such habitat appears to depend on the severity of winter conditions in the region. In the deep snow/long winter regions, deer are regularly restricted to forest stands which provide both food and thermal cover (critical winter habitat). In areas where winters are less severe, deer have regular access to regenerating cutovers and deciduous-coniferous stands which provide an abundance of browse. Stands which supply critical winter shelter habitat have the following general characteristics (Boer et al. 1982, DNRE report; Marston 1986, Maine Coop. Wildl. Res. Unit Misc. Pub. 689; Weber et al. 1983, Wildl. Soc. Bull. 11: 331-338):

Dominant Species Composition	Tree species	- spruce, balsam fir, eastern cedar, eastern hemlock
	FDS Forest unit (FUNA)	- SPBF, BFSP, OTSW, SPIH, SPTH, BFIH, BFTH
Site/ Location	Stand size	- > 5 ha but may be smaller if surrounded by potential shelter
	Slope/aspect	- < 45° / S to SW
	Elevation	- ?
	Site quality	- high (browse)

Stand Structure	SW Crown closure	- 50% - 70%
	SW Tree height	- > 10 metres
	SW Basal area	- > 20 m^2/ha
	SW Volume	- > 35 m^3/ha
	Mean dbh (spruce)	- 12cm
	SW Stems per hectare	- > 250
	Development stage	- mature to overmature

Potential Future Winter Habitat. Potential future winter habitat should have the dominant species composition and site characteristics of current winter habitat but not the desired structure. REGENERATING (R) and YOUNG (Y) intolerant deciduous dominated mixedwood stands may provide shelter habitat in the future as the coniferous component becomes more prominent. Some portion of the Cut DS will provide shelter habitat in the future though it is difficult to assess what regeneration has become established without field knowledge of the area. Plantations and precommercially thinned stands should not be considered as potential future winter habitat at this time.

PROCEDURES AND GUIDELINES FOR DWAMU ESTABLISHMENT

Eligible Deer Wintering Areas (DWA). Initial efforts at defining DWAMU should be directed at DWAs larger than 200 hectares.

Initial DWA Assessment. The forest structure of each DWA should be assessed using the area summary and field knowledge of the area. Priority for DWAMU establishment should be given to larger active DWA with an unbalanced coniferous forest age class distribution skewed to overmature (predominantly overmature> mature> immature). These DWA are at greatest risk due to natural stand breakup.

Assessment of Future Habitat Requirements. In order of priority, the age class structure of each DWA should be examined to determine how many hectares (ha) of potential future winter habitat and in which DS is required to provide a sustained yield of winter habitat. Though it would be ideal to have equal amounts of potential habitat in each DS from CUT (C) through to OVERMATURE (O), it is not necessary from a habitat supply stand point. The unbalanced age class structure of the coniferous forest as a whole would make it difficult to achieve a completely balanced age class distribution. Referring to the sample DWA age class distribution in Figure 1, the following future winter habitat requirements can be identified:

Sample DWA#1 - The current age distribution of DWA#1 (Figure 1) shows an unbalanced age class structure skewed to O DS (500ha of current winter habitat) with an additional 200 ha of potential future habitat in the R DS. To provide a sustained yield of winter habitat it is necessary to identify an additional 500ha of potential future habitat in the IMMATURE (I) DS and 300ha in the R DS. The resulting DWAMU would be approximately 1500ha (Figure 2).

The example given above is rather extreme. Most DWA, as currently identified, do not have all their existing winter habitat in the O DS. Where the existing winter habitat is distributed over a number of DS (I,M,O) there should be more flexibility in defining future winter habitat requirements. Also less additional area should be required.

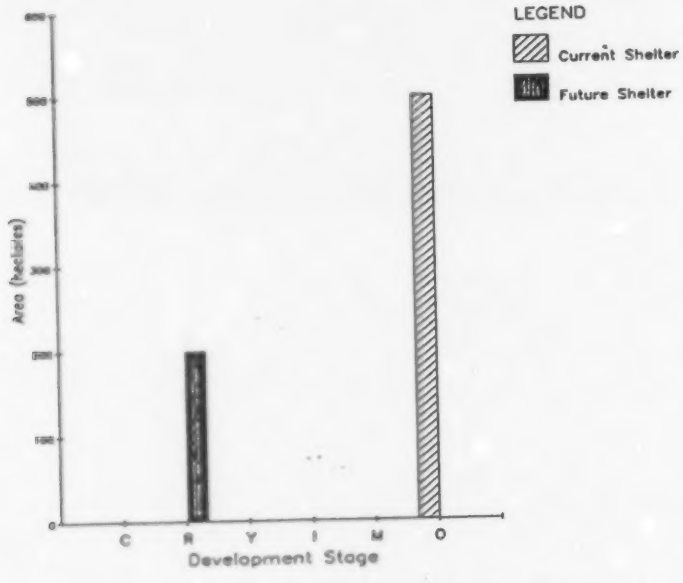


Figure 1. Sample deer wintering area (DWA# 1) coniferous forest age class distribution.

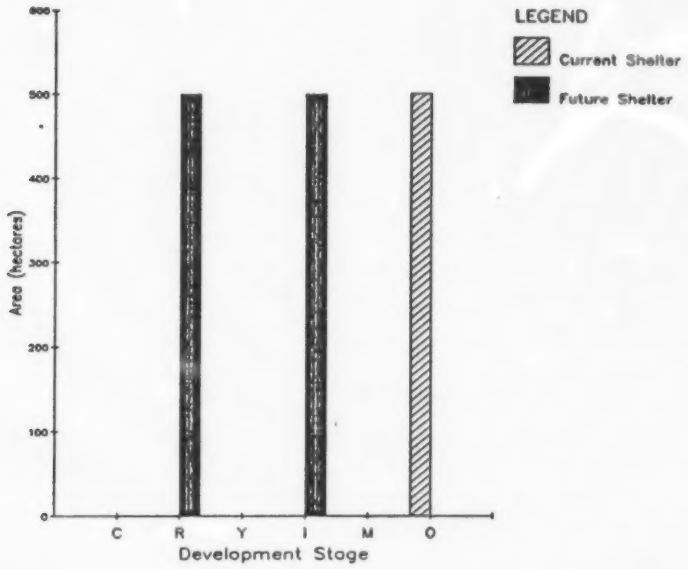


Figure 2. Coniferous forest age class distribution within the deer wintering area management units established for DWA# 1.

Selecting Potential Future Winter Habitat Stands. With the general requirement for additional future habitat identified, stands capable of providing that habitat must be selected. Deer are considered to be traditional in their use of areas for winter habitat. Their ability to move across or along a watershed over a relatively short period of time to seek new winter habitat is questionable. The search for future winter habitat stands should radiate outwards from the existing DWA and remain within the original watershed when possible. At the stand level the following guidelines should be considered where choices between stands are required.

Individual Stand Selection Guidelines:

Species composition	-	favour coniferous and coniferous-deciduous stands.
	-	favour stands dominated by eastern cedar (EC) and/or eastern hemlock (EH) over (>) spruce (SP) > balsam fir (BF) > black spruce (BS). Pine dominated and poor-site-spruce (often BS) should not be considered (See: Site Quality).
SW Crown closure	-	favour stands with high SW CC (> 50%).
Slope	-	favour gentler slopes.

Aspect	-	favour southerly over northerly aspects but do not excluded stands based on aspect.
Elevation	-	favour lower elevations.
Location	-	favour stands within the same watershed as the existing shelter and those closer to watercourses.
Stand size	-	potential shelter habitat stands which are > 5 ha and contiguous with other potential shelter habitat should be favoured over stands < 5 ha and surrounded by non potential habitat (e.g. pure deciduous).
Human access	-	favour areas with lower human access potential (i.e. fewer all season roads). Favour areas with trail access over road access.
Plantations	-	plantations and thinned stands are not to be considered as potential future shelter habitat.
Site Quality	-	favour productive well drained sites over nonproductive poorly drained sites (except cedar). Productive sites are more likely to support favoured browse species.

To select and assess future winter habitat stands the following items are required: a knowledge of the area; 1:50 000 DWA map(s) (DWA location and proximity of adjacent DWA); 1:12 500 FDS map(s) with updated CUT information (stand#, attributes, area, location and roads); 25 year forest management plan harvest block maps; 1:50 000 NTS map(s) (slope, aspect and watershed); stand selection tally sheet to keep track of future winter habitat stands selected.

As future winter habitat stands are identified they are to be recorded on the stand selection tally sheet. As area is accumulated it should be compared with the identified requirement. When the area of potential winter habitat stands identified equals the requirement, the selected stands should be assessed. An attempt should be made to replace future winter habitat stands which are small and isolated with larger potential habitat stands contiguous with other shelter. Once selected stands have been assessed and any changes made, the initial DWAMU boundary can be delineated.

Delineating the DWAMU Boundary. The initial DWAMU boundary will follow stand boundaries and be drawn on 1:12 500 FDS maps. Once the final boundary has been agreed upon by all concern parties (DNRE & Licensees) the boundary may be digitized to facilitate easier updating in the future. Guidelines for boundary

establishment are listed below.

Guidelines for DWAMU Boundary Establishment:

Inclusion of non-winter habitat stands - all stands which fall within a group of potential future winter habitat stands are considered within the DWAMU.

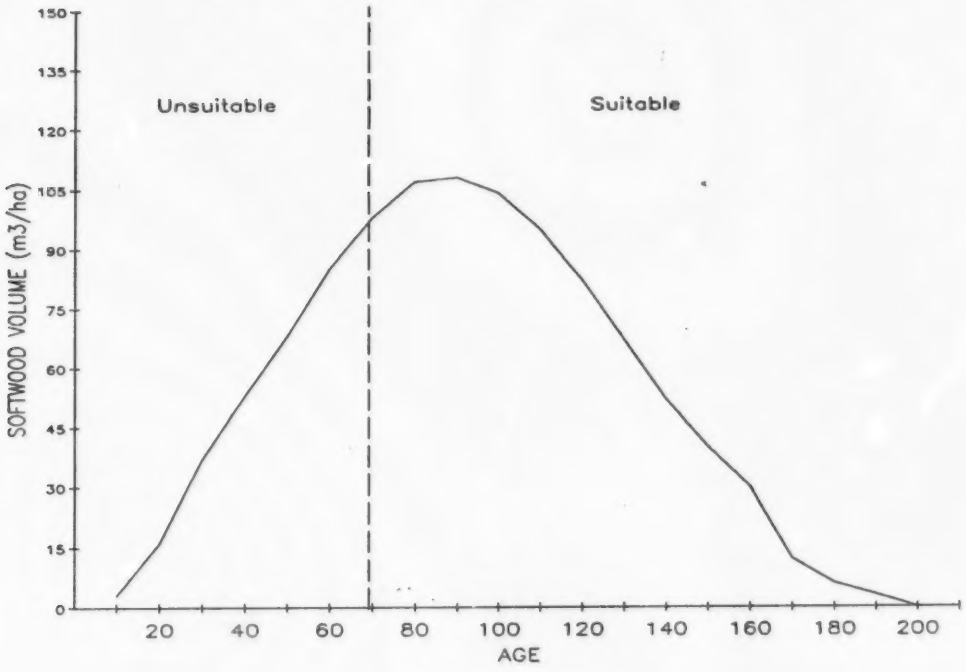
Travel corridors - potential future winter habitat should be connected to existing winter habitat by travel corridors a minimum of 100 metres wide. Travel corridors should not cut across watersheds but instead follow watercourses when possible.

Once the boundary has been established, a copy of the list of potential future winter habitat stands selected and the 1:12 500 FDS map should be forwarded to the Forest Land Habitat Program. The boundaries will be entered into the DWA computer data base and an updated area summary will be produced. Each DWAMU will be examined by regional and program staff to ensure it meets the intended objective for that DWAMU.

APPENDIX 7.

EXAMPLE OF A FOREST CLASS VOLUME YIELD CURVE AND A HABITAT WINDOW FOR AMERICAN MARTEN

LICENSE 4 MARTEN HABITAT WINDOW
SPRUCE/TOLERANT HARDWOOD (ALL CROWN CLOSURES)



APPENDIX 8.

NEW BRUNSWICK FOREST RESEARCH ADVISORY COMMITTEE (NBFRAC)
NBFRAC WILDLIFE TECHNICAL COMMITTEE

NEW BRUNSWICK FOREST RESEARCH ADVISORY COMMITTEE (NBFRAC)

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APPENDIX 9.

FOREST LAND HABITAT MANAGEMENT PROGRAM
PROGRAM STAFF

FOREST LAND HABITAT MANAGEMENT PROGRAM

PROGRAM STAFF

Position	Name	Status
Program Leader (DNRE)	M. Sullivan	Acting
Habitat Relationships Leader (WHC)	D. Beaudette	Contract
Habitat Relationships Biologist (DNRE)	J. Niederleitner	Contract
Habitat Coordination Leader (DNRE)	M. Sullivan	Permanent
Habitat Coordination Biologist (WHC)	S. Gordon	Contract
Computer Systems Leader (DNRE)	L. Vietinghoff	Permanent
Computer Systems Specialist (WHC)	J. Feltmate	Contract

M. Sullivan is acting as Program Leader in addition to his other duties as Habitat Coordination Leader. D. Beaudette successfully competed for the permanent Habitat Relationship Biologist position; the position commences 1 June 1990. M. Elderkin terminated his position as Habitat Relationships Biologist with the completion of the Forest Bird Project. S. Lusk has been hired as a Habitat Relationships Biologist commencing 1 April 1990.